(19) Japanese Patent Office (JP)

(12) UNEXAMINED PATENT GAZETTE (A)

(11) Unexamined Patent Application

No. 4-161056

(43) Published June 4, 1992

(51) Int. Cl.[5]	ID Symbol	Internal File No.
H 02 K 55/00	ZAA	7254-5H

Request for Examination: not yet submitted
Number of Inventions: 4 (3 pages total)

---

(54) Title of the Invention: Superconducting Power Plant and Operating Method Thereof

(21) Application No.: 2-285818

(22) Application Date: October 25, 1990

(72) Inventor: Makoto Adachi
c/o Toshiba Corporation Fuchu Plant
1 Toshiba-cho
Fuchu-shi, Tokyo

(71) Applicant: Toshiba Corporation
72 Horikawa-cho
Saiwai-ku, Kawasaki
Kanagawa Prefecture

(74) Representative: Kensuke Norichika, Patent Attorney

SPECIFICATIONS

1. Title of the Invention

Superconducting Power Plant and Operating Method Thereof

2. Claims

(1) Superconducting power plant, characterized by having a cooler for supplying a cooling medium for bringing a superconducting generator to a superconducting state, an evaporator for evaporating a condensed secondary medium for driving a turbine connected to the above-mentioned superconducting generator, and a condenser for receiving the cooling medium from the above-mentioned cooler and condensing the steam of the secondary medium after completing work in the above-mentioned turbine.

(2) Superconducting power plant described in Claim 1, characterized by the cooler supplying the cooling medium to both the superconducting generator and the condenser in a linear supply cycle.

(3) Superconducting power plant described in Claim 1, characterized by the cooler supplying the cooling medium to the superconducting generator in one supply cycle and the cooling medium to the condenser in another supply cycle controlled separately.

(4) Superconducting power plant operating method, characterized by supplying a cooling medium from a cooler in a separate supply cycle, operating a condenser, and starting a turbine rotating by a secondary medium when starting a superconducting generator, supplying the cooling medium to the superconducting generator and a condenser in a linear supply cycle after the turbine has started and moving to a superconducting state while rotating the turbine, and supplying the cooling medium to the superconducting generator and the condenser in separate supply cycles and energizing the superconducting generator to generate power when it has

reached a superconducting state.

3. Detailed Explanation of the Invention

[Purpose of the Invention]

[Industrial Field of Application]

This invention pertains to a superconducting power plant supplied with a cooling medium.

[Prior Art]

As shown in Figure 3, a superconducting power plant is provided with driver 1 such as a motor, water wheel, or steam turbine, superconducting generator 2 operated by this driver, and cooler 3 for supplying a cooling medium (such as liquid He, liquid N_2, He gas, or N_2 gas) for cooling the superconducting coil of this superconducting generator 2. This cooler 3 supplies the cooling medium to superconducting generator 2, recovers the cooling medium (for example, vaporized He) from superconducting generator 2 after completing work, and restores it to liquid He or the like.

In this superconducting power plant, superconducting generator 2 is rotated by driver 1 and the cooling medium is supplied to superconducting generator 2 by cooler 3. As generator 2 gradually cools, reaches a superconducting state, and begins functioning as a superconducting generator, generator 2 becomes energized and generates power.

[Problems that the Invention is to Solve]

To bring generator 2 in a superconducting power plant to a superconducting state when started as described above, a cooling medium such as N_2 gas, He gas, liquid N_2, or liquid He is used, and must cool in stages. Generator 2 must already be rotating during this cooling to prevent warping due to temperature change. Therefore, a motor, thermal power, or water power drive

source is indispensable for rotating driver 1 for this purpose. When the drive source for this driver is thermal power or water power, it produces a large-scale plant.

In addition, the cooling medium (cooling gas) recovered after cooling generator 2 still has cooling capacity.

Therefore, the purpose of this invention is to offer a compact superconducting power plant by using the cooling capacity of the cooling medium for a superconducting generator effectively.

[Constitution of the Invention]

[Means of Solving the Problems]

The superconducting power plant of this invention is provided with a cooler, a condenser, and an evaporator. The cooler supplies a cooling medium for bringing a superconducting generator to a superconducting state. The evaporator evaporates a condensed secondary medium for driving a turbine connected to the superconducting generator. The condenser receives the cooling medium from the cooler, and condenses the steam of the secondary medium after completing work in the turbine.

In addition, the cooler supplies the cooling medium to the superconducting generator and the condenser in either separate supply cycles or a linear supply cycle.

[Operation]

When starting, the cooling medium is supplied, the condenser starts functioning, and the turbine is started rotating by the secondary medium. After the turbine has started, the cooling medium is also supplied to the superconducting generator, and this moves to a superconducting state while the turbine rotates. Moreover, when the superconducting generator reaches a superconducting state, it becomes energized and generates power.

At each stage of supply in this operation, the cooling medium may be supplied by separate supply cycles during all stages, or may be supplied by separate supply cycles when starting and when generating, and switched to a linear supply cycle when the generator moves to a superconducting state.

[Working Examples]

Working examples of this invention will be explained referring to the figures.

Figure 1 is a schematic system diagram of a superconducting power plant of this invention. Parts in Figure 1 that are the same as in Figure 2 are labeled by the same reference numbers. For the drive source of turbine 1, a secondary medium closed cycle is constructed of condenser 4, pump 5 for supplying a secondary medium, and evaporator 6. Condenser 4 is used to drive turbine 1, and condenses the secondary medium (such as Freon gas) after completing work by being supplied the cooling medium (such as liquid He) for superconducting generator 2. Evaporator 6 evaporates the secondary medium fed by pump 5 and condensed by condenser 4 by being supplied seawater or warm water, then feeds this secondary medium to drive turbine 1. When a low boiling point gas such as Freon gas is employed as the secondary medium, this can be evaporated even at the temperature of seawater. The cooling medium here is supplied from cooler 3 to condenser 4 through valve 7 and recovered through valve 8 to form cooling medium cycle S1.

The operation of the constitution described above will be explained next. When starting, valves 7 and 8 are opened, and cooler 3 circulates the cooling medium to operate condenser 4 and circulates a medium such as seawater to operate evaporator 6. In addition, turbine 1 is driven by the secondary medium from evaporator 6. Furthermore, once rotating, turbine 1 circulates the cooling medium to superconducting generator 2 through valves 9 and 10. Moreover, when this

reaches a superconducting state, it becomes energized and generates power.

A compact power plant system can be formed by condensing the secondary medium by condenser 4 using the cooling medium used for cooling superconducting generator 2 and by driving turbine 1 by the secondary medium evaporated by evaporator 6 during this operation.

Next, another working example will be explained using Figure 2. Parts in Figure 2 that are the same as in Figure 1 are labeled by the same reference numbers. This working example has a constitution capable of switching to cooling medium cycle S2, in which the cooling medium used by superconducting generator 2 is supplied directly to condenser 4. That is, because the cooling medium used by superconducting generator 2 can cool this while still rotating turbine 1, this cooling medium is supplied directly to condenser 4 through valve 11 during the interval that turbine 1 is driven and superconducting generator 2 reaches a superconducting state.

The operation of the constitution described above will be explained next. When starting, valves 7 and 8 are opened with valves 9, 10, and 11 still closed, and the cooling medium is circulated by cooler 3 to operate condenser 4 in the same way as in the first working example. In addition, once turbine 1 is rotating, valves 9 and 11 are opened and valve 7 is closed. As a result, condenser 4 is operated by the cooling medium used by superconducting generator 2 while the cooling medium cools the generator until it reaches a superconducting state. Furthermore, valves 7 and 10 are opened and valve 11 is closed after this reaches a superconducting state. That is, because the cooling capacity of condenser 4 is reduced during generating, superconducting generator 2 and condenser 4 are cooled by separate cooling medium cycles, thereby keeping the generator in a superconducting state and rotating turbine 1. In this state, moreover, the generator becomes energized and generates power.

[Effects of the Invention]

According to this invention, the cooling medium used to cool the superconducting generator is used by the condenser as the cooling medium in a secondary medium closed cycle for driving the turbine. As a result, this invention can offer a compact superconducting power plant.

4. Brief Explanation of the Figures

Figures 1 and 2 are system schematic diagrams of superconducting power plants of this invention. Figure 3 is a system schematic diagram of a superconducting power plant by prior art.

1 … turbine	2 … superconducting generator
3 … cooler	4 … condenser
5 … pump	6 … evaporator
7, 8, 9, 10, 11 … valves	

Figure 1

3: cooler, 4: condenser, 6: evaporator, ↓: seawater, warm water

Figure 2

3: cooler, 4: condenser, 6: evaporator, ↓: seawater, warm water

Figure 3

←: power transmission